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(Amended Specification and Claims under PCT Article 34)

International Application No.: PCT/JP03/08352

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Title: PROCESSING APPARATUS AND PROCESSING METHOD

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Amendment under Patent Law 11

To the Patent Office Director General;

1. Identification of the International application PCT/JP03/08352

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4. Object for Amendment

Description and Claims

5. Contents of Amendment

(1) Please amend page 3, line 19 to line 24 in the description "comprising a film removing member for selectively removing the film on a predetermined portion of an outer peripheral part of the substrate, the film removing member including a plasma supply part for supplying plasma of a reactive gas to the film on the predetermined portion and a suction port for sucking an atmosphere in a vicinity of the predetermined portion." to "comprising: a film removing member for selectively removing the film on a predetermined portion of an outer peripheral part of the substrate; and a rotating mechanism for rotating the substrate, the film removing member having a shape which is composed of a vertical part, an upper part formed in a horizontal direction from an upper end part of the vertical part, and a lower part formed in a same direction as the horizontal direction from a lower end part of the vertical part, being formed so that the outer peripheral part of the substrate is allowed to be inserted into an opening which is formed by the upper part and the lower part, and including a plasma supply part for supplying plasma of a reactive gas to the film on the predetermined portion and a suction port for sucking an atmosphere in a vicinity of the predetermined portion from outside the substrate, and the plasma supply part being attached to a ceiling surface inside the film removing member surrounded by the vertical part, the upper part, and the lower part".

(2) Please amend page 4, line 3 to line 5 in the description "According to the present invention, it is possible to supply the reactive plasma to the film

on the predetermined portion of the outer peripheral part of the substrate" to "According to the present invention, by inserting the outer peripheral part of the substrate into the film removing member, rotating the substrate side by the rotating mechanism, and supplying the plasma from the ceiling surface inside the film removing member, it is possible to supply the reactive plasma to the film on the predetermined portion of the outer peripheral part of the substrate".

(3) Please amend page 4, line 8 to line 9 in the description "form an atmospheric current by suction from the supply port" to "form an atmospheric current which goes to the outside above the outer peripheral part of the substrate by suction from the supply port".

(4) Please delete page 4, line 24 to page 5, line 14 in the description "The suction port may be placed so as to be allowed to suck the atmosphere in the vicinity of the predetermined portion from outside the substrate, and in this case, an atmospheric current which goes to the outside is formed above the outer peripheral part of the substrate, and therefore, the sloped part is easy to form, for example, at the end part of the film.

It is also possible that the film removing member has a shape which is composed of a vertical part, an upper part formed in a horizontal direction from an upper end part of the vertical part, and a lower part formed in the same direction as the horizontal direction from a lower end part of the vertical part, and is formed so that the outer peripheral part of the substrate is allowed to be inserted into an opening which is formed by the upper part and the lower part, and that the plasma supply part is attached to a ceiling surface inside the film removing member surrounded by the vertical part, the upper part, and the lower part. In this case, by inserting the outer peripheral part of the substrate

inside the film removing member and supplying the plasma from the ceiling surface, the aforementioned formation of the slope part at the end part of the film and removal of the residue can be performed."

(5) Please delete page 6, line 4 to line 8 in the description "The processing apparatus may further comprise a rotating mechanism for rotating the substrate, and in this case, it is possible to place the film removing member at a specific position of the outer peripheral part of the substrate and remove the film on the outer peripheral part of the substrate by rotating the substrate side. Moreover,".

(6) Please delete page 8, line 1 to line 12 in the description.

(7) Please amend claim 1 on page 38 as follows.

Amend "comprising: a film removing member for selectively removing the film on a predetermined portion of an outer peripheral part of the substrate" to "comprising: a film removing member for selectively removing the film on a predetermined portion of an outer peripheral part of the substrate; and a rotating mechanism for rotating the substrate", and amend "said film removing member including a plasma supply part for supplying plasma of a reactive gas to the film on the predetermined portion and a suction port for sucking an atmosphere in a vicinity of the predetermined portion." to "said film removing member having a shape which is composed of a vertical part, an upper part formed in a horizontal direction from an upper end part of the vertical part, and a lower part formed in a same direction as the horizontal direction from a lower end part of the vertical part, being formed so that the outer peripheral part of the substrate is allowed to be inserted into an opening which is formed by the upper part and the lower part, and including a plasma supply part for supplying plasma of a reactive gas to the film on the

predetermined portion and a suction port for sucking an atmosphere in a vicinity of the predetermined portion from outside the substrate, and said plasma supply part being attached to a ceiling surface inside said film removing member surrounded by the vertical part, the upper part, and the lower part."

(8) Please delete claim 2 and claim 3 on page 38.

(9) Please amend in claim 4 on page 38 "The processing apparatus as set forth in claim 3, wherein" to "The processing apparatus as set forth in claim 1, wherein".

(10) Please delete claim 7 on page 39, claim 14 on page 40, claim 15 from page 40 to page 41, and claim 16 on page 41.

6. List of Attached Documents

(1) Description: page 2 to page 8

(2) Claims: page 38 to page 42

processing, whereby as shown in FIG. 21, an end part of an insulating film 150 on a wafer W becomes an almost vertical surface, and at an upper end part thereof, a corner part 150a is formed. Then, when the polishing processing is performed after upper films such as a hard mask 151, a metal barrier 152, and the like are formed as described above, an intensive load is imposed on the corner part 150a by the pressure of a polishing pad 153. Due to this intensive load, the hard mask 151, the metal barrier, and the like in the vicinity of the corner part 150a peel off the insulating film 150. In particular, the adhesion between the insulating film 150 and the hard mask 151 is week, so that the peeling tends to occur.

Moreover, residues 154 of organic matters, the film, and the like remain on the surface of the outer peripheral part of the wafer from which the outer peripheral film is removed. If the hard mask 151 is formed on the

surface of the outer peripheral part of the wafer in this state, the adhesion between the hard mask 151 and the surface of the wafer lowers. Therefore, when the polishing processing is performed thereafter, the hard mask 151 and the like on the surface of the outer peripheral part of the wafer peel off the wafer W.

The aforementioned peeling of the hard mask 151 and the like becomes a cause of particles, and it is undesirable. Further, the peeling of the hard mask 151 and the like at the corner part 150a causes a product deficiency of the wafer since post-processing such as exposure processing in this portion cannot be properly performed.

Disclosure of the Invention

The present invention is made in view of the aforementioned point, and its object is to provide a processing apparatus and a processing method for previously subjecting a substrate such as a wafer to predetermined processing to prevent a hard mask or the like from peeling off during polishing processing performed later.

The present invention is a processing apparatus for processing a substrate on a surface of which a film is formed, comprising: a film removing member for selectively removing the film on a predetermined portion of an outer peripheral part of the substrate; and a rotating mechanism for rotating the substrate, the film removing member having a shape which is composed of a vertical part, an upper part formed in a horizontal direction from an upper end part of the vertical part, and a lower part formed in a same direction as the horizontal direction from a lower end part of the vertical part, being formed so that the outer peripheral part of the substrate is allowed to be inserted into an

opening which is formed by the upper part and the lower part, and including a plasma supply part for supplying plasma of a reactive gas to the film on the predetermined portion and a suction port for sucking an atmosphere in a vicinity of the predetermined portion from outside the substrate, and the plasma supply part being attached to a ceiling surface inside the film removing member surrounded by the vertical part, the upper part, and the lower part. Incidentally, the plasma supply part may be what jets gas which is previously converted into plasma to the film on the outer peripheral part of the substrate or may be what converts a reactive gas in the vicinity of the outer peripheral part of the substrate into plasma and supplies the plasma indirectly to the outer peripheral part of the substrate.

According to the present invention, by inserting the outer peripheral part of the substrate into the film removing member, rotating the substrate side by the rotating mechanism, and supplying the plasma from the ceiling surface inside the film removing member, it is possible to supply the reactive plasma to the film on the predetermined portion of the outer peripheral part of the substrate and chemically react the plasma with the film on the predetermined portion. Further, it is possible to separate the film by the chemical reaction and remove components of the separated film from the suction port. Furthermore, it is possible to form an atmospheric current which goes to the outside above the outer peripheral part of the substrate by suction from the supply port and guide the plasma supplied from the plasma supply part. Accordingly, by combining the supply and the guidance of the plasma, for example, it becomes possible to bring the atmospheric current which carries the plasma into oblique contact with an end part of the film on the outer peripheral part of the substrate and form a sloped part at the end part

of the film. As a result, for example, even if a polishing pad is pressed on the substrate in the aforementioned polishing processing, a load does not concentrate on the vicinity of the end part of the film, which can prevent, for example, a hard mask as an upper film from peeling off. Moreover, the film remaining on the surface of the outer peripheral part of the substrate after the aforementioned outer peripheral film removing processing can be removed. As a result, the later adhesion between the surface of the outer peripheral part and the hard mask or the like as the upper film improves. Hence, even if the polishing pad is pressed on the surface of the outer peripheral part, the peeling of the hard mask or the like can be prevented.

Incidentally, the suction port may be provided inside the film removing member and at a position facing the opening.

Moreover, the plasma supply part may be provided in a portion facing the predetermined portion in the film removing member, and the suction port may be provided outside the plasma supply part. In this case, the suction ports may be provided facing to each other with the plasma supply part therebetween. In the film removing member thus structured, after the film is separated and removed by gas plasma supplied from the plasma supply part, components of the film can be sucked as they are from the suction port. Further, the formation of the sloped part is easy. Furthermore, by controlling the supply amount and the suction amount of the gas plasma, the slope degree of the sloped part can be adjusted. According to verification of the inventors, if the supply amount of gas plasma is increased, the slope of the sloped part becomes gentler, and if the suction amount from the suction port is increased, the slope becomes steeper.

The processing apparatus may further comprise a horizontal driving

part for horizontally moving the film removing member. This horizontal driving part allows the film removing member to come close to or go away from the substrate. Accordingly, the film removing member can get access to the outer peripheral part of the substrate at a predetermined timing. Moreover, this horizontal driving part makes it possible to arbitrarily determine a removal range of the film on the outer peripheral part of the substrate and remove the film in a predetermined region on the outer peripheral part side of the substrate in accordance with a process. Further, a laser mark part in which substrate identification information such as a lot number, characteristics or the like of the substrate and a cut-out part (notch part) provided in the outer peripheral part of the substrate to facilitate the determination of the crystal orientation of the substrate can be partially removed.

The processing apparatus may further comprise a controlling part for controlling a suction pressure from the suction port. Since the suction pressure can be controlled, the flow path, flow rate, flow amount, and so on of the atmospheric current containing the plasma formed above the outer peripheral part of the substrate can be controlled. As a result, the film on the outer peripheral part can be removed in a predetermined shape.

The plasma supply parts may be provided at plural positions along a radial direction of the substrate in the film removing member. Even where the supply range of one plasma supply part is narrow, the plasma can be supplied in a wider range at a time. Moreover, when film removal operations differ according to distances from the center of the substrate, plural removal operations can be performed at a time, for example, by changing the supply mount of plasma from each plasma supply part. Namely, the sloped

part is formed at the end part of the outer peripheral film by the inner plasma supply part, and the residue on the surface of the outer peripheral part of the substrate can be removed by the outer plasma supply part. Further, the plasma supply parts may be provided at plural positions along a circumferential direction of the substrate in the film removing member. By providing the plasma supply parts at plural positions, the film in a wider range can be removed at a time, and the film removal operation can be made more speedy.

The plasma supply part may be an emitting part of a ray for converting the reactive gas into the plasma, and in this case, the reactive gas such as oxygen in the vicinity of the outer peripheral part of the substrate is converted into the plasma by emitting the ray, and this plasma is supplied to the film on the outer peripheral part. The film removing member may further include a reactive gas jetting part for jetting the reactive gas. This film removing member can actively supply the reactive gas in the vicinity of the outer peripheral part of the substrate, whereby the generation of the plasma by the ray is accelerated, and thereby the removal of the film by the plasma can be performed more certainly and in a shorter time.

The processing apparatus may further comprise an oxygen radical supply part for supplying oxygen radicals toward at least an outer peripheral part of a surface (for example, a rear surface), which is different from the surface on which the film is formed, of the substrate. When the oxygen radicals are supplied, organic matters or the like which adhere to or remain on the rear surface and the edge portion of the substrate can be effectively removed.

The processing apparatus may further comprise a heating unit such as

an infrared lamp for heating the substrate by an infrared ray. This makes it possible to heat the substrate without touching it and accelerate a reaction. Accordingly, the time required for the removal of the film and the formation of the sloped part can be shortened.

The processing apparatus may further comprise, in addition to the film removing member, a removal solution discharge nozzle for discharging a removal solution to the outer peripheral part of the substrate to remove the film on the outer peripheral part or a coating solution discharge nozzle for discharging a coating solution to the substrate to form the film on the substrate. According to this processing apparatus, the aforementioned film forming processing and outer peripheral film removing processing performed after the film forming processing can be made in the same processing apparatus as the processing of removing the film on the predetermined portion of the outer peripheral part.

A processing method of the present invention is a processing method for processing a substrate on a surface of which a film is formed, comprising the step of forming in the film on an outer peripheral part of the substrate a sloped part such that its film thickness becomes thinner toward an end part.

According to the method of the present invention, when a hard mask which is an upper film or the like is formed later on the substrate and then subjected to polishing processing, the load of the polishing pad described above no longer concentrate on the film at the end part of the outer peripheral part. As a result, the peeling of the hard mask due to the intensive load no longer occurs, which can prevent the occurrence of particles and a product deficiency which are caused by peeling.

CLAIMS:

1. A processing apparatus for processing a substrate on a surface of which a film is formed, comprising:

a film removing member for selectively removing the film on a predetermined portion of an outer peripheral part of the substrate,

said film removing member including a plasma supply part for supplying plasma of a reactive gas to the film on the predetermined portion and a suction port for sucking an atmosphere in a vicinity of the predetermined portion.

2. The processing apparatus as set forth in claim 1, wherein

said suction port is placed so as to be allowed to suck the atmosphere in the vicinity of the predetermined portion from outside the substrate.

3. The processing apparatus as set forth in claim 1, wherein

said film removing member has a shape which is composed of a vertical part, an upper part formed in a horizontal direction from an upper end part of the vertical part, and a lower part formed in a same direction as the horizontal direction from a lower end part of the vertical part, and is formed so that the outer peripheral part of the substrate is allowed to be inserted into an opening which is formed by the upper part and the lower part, and said plasma supply part is attached to a ceiling surface inside said film removing member surrounded by the vertical part, the upper part, and the lower part.

4. The processing apparatus as set forth in claim 3, wherein

said suction port is provided inside said film removing member and at a position facing the opening.

5. The processing apparatus as set forth in claim 1, wherein said plasma supply part is provided in a portion facing the predetermined portion in said film removing member, and said suction port is provided outside said plasma supply part.

6. The processing apparatus as set forth in claim 5, wherein said plasma supply part is provided in a portion facing the predetermined portion in said film removing member, and said suction ports are provided facing to each other with said plasma supply part therebetween.

7. The processing apparatus as set forth in claim 1, further comprising; a rotating mechanism for rotating the substrate.

8. The processing apparatus as set forth in claim 1, further comprising: a horizontal driving part for horizontally moving said film removing member.

9. The processing apparatus as set forth in claim 1, further comprising: a controlling part for controlling a suction pressure of said suction port.

10. The processing apparatus as set forth in claim 1, wherein said plasma supply parts are provided at plural positions along a radial

direction of the substrate in said film removing member.

11. The processing apparatus as set forth in claim 1, wherein

said plasma supply parts are provided at plural positions along a circumferential direction of the substrate in said film removing member.

12. The processing apparatus as set forth in claim 1, wherein

said plasma supply part is an emitting part of a ray for converting the reactive gas into the plasma.

13. The processing apparatus as set forth in claim 10, wherein

said film removing member further includes a reactive gas jetting part for jetting the reactive gas.

14. A processing apparatus for processing a substrate on a surface of which a film is formed, comprising:

a film removing member for selectively removing the film on a predetermined portion of an outer peripheral part of the substrate,

said film removing member including a laser radiating part for radiating a laser to the film on the predetermined portion and a suction port for sucking an atmosphere in a vicinity of the predetermined portion.

15. A processing apparatus for processing a substrate on a surface of which a film is formed, comprising:

a film removing member for selectively removing the film on a predetermined portion of an outer peripheral part of the substrate,

said film removing member including a liquid jetting part for jetting a liquid at a high pressure to the film on the predetermined portion and a suction port for sucking an atmosphere in a vicinity of the predetermined portion.

16. A processing apparatus for processing a substrate on a surface of which a film is formed, comprising:

a film removing member for selectively removing the film on a predetermined portion of an outer peripheral part of the substrate,

said film removing member including an ultraviolet radiating part for radiating an ultraviolet ray to the film on the predetermined portion and a suction port for sucking an atmosphere in a vicinity of the predetermined portion.

17. The processing apparatus as set forth in claim 1, further comprising:

a removal solution discharge nozzle for discharging a removal solution to the outer peripheral part of the substrate to remove the film on the outer peripheral part, in addition to said film removing member.

18. The processing apparatus as set forth in claim 1, further comprising:

a coating solution discharge nozzle for discharging a coating solution to the substrate to form the film on the substrate.

19. The processing apparatus as set forth in claim 1, further comprising:

an oxygen radical supply part for supplying oxygen radicals toward at least an outer peripheral part of a surface, which is different from the surface

on which the film is formed, of the substrate.

20. The processing apparatus as set forth in claim 1, further comprising:

a heating unit for heating the substrate by an infrared ray.

21. A processing method for processing a substrate on a surface of which a film is formed, comprising the step of:

forming in the film on an outer peripheral part of the substrate a sloped part such that its film thickness becomes thinner toward an end part.

22. The processing method as set forth in claim 21, further comprising the steps of:

selectively removing the film on a portion of the outer peripheral part of the substrate; and

forming the sloped part such that its film thickness becomes thinner toward the portion from which the film is removed.

23. The processing method as set forth in claim 21, further comprising the step of:

oxidizing a surface of the sloped part.

24. The processing method as set forth in claim 23, wherein

the oxidation is performed by supplying oxygen radicals.

25. A processing method for processing a substrate on a surface of which a film is formed, comprising the steps of:

removing the film on an outer peripheral part of the substrate; and

removing a residue of the film or the like adhering to the surface of the substrate of the outer peripheral part from which the film is removed.

26. The processing method as set forth in claim 25, further comprising the step of:

oxidizing the surface of the substrate from which the residue is removed.

27. The processing method as set forth in claim 26, wherein

the oxidation is performed by supplying oxygen radicals.

28. A processing method for processing a substrate on a surface of which a film is formed, comprising the steps of:

removing the film on an outer peripheral part of the substrate;

removing a residue of the film or the like adhering to the surface of the substrate of the outer peripheral part from which the film is removed; and

forming, at an end part of the film after the film is removed, a sloped part such that its film thickness becomes thinner toward the end part.

29. The processing method as set forth in claim 28, further comprising the step of:

oxidizing the surface of the substrate from which the residue is removed and a surface of the sloped part.

30. The processing method as set forth in claim 29, wherein

the oxidation is performed by supplying oxygen radicals.

31. The processing method as set forth in claim 21, wherein in said step of forming the slope part, the substrate is heated.

32. The processing method as set forth in claim 25, wherein when the residue is removed, the substrate is heated.